Simultaneous emission and transmission imaging for PET-MRI using time-of-flight information

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I. Introduction

In the past few years, much research has concentrated on combining PET and MRI. To obtain quantitative PET images the data should be corrected for attenuation of the 511 KeV photons. Predicting attenuation values from MR images is difficult because in most MRI sequences, air and bone do not produce any signal, while their attenuation coefficients are completely different. In order to derive an accurate attenuation map we used a transmission source based on an annulus cylinder filled with FDG. By using the time-of-flight information of the photons we are able to acquire the transmission and PET emission data simultaneously.

II. Materials and methods

A transmission scan of a digital torso phantom was simulated in GATE and an iterative reconstruction algorithm was used to derive the attenuation coefficients at 511 keV for lung, muscle and bone [1]. To perform a first measurement we constructed the transmission source using PVC material and an 150m long tube. A transmission scan of a uniform water phantom was acquired on the philips GEMINI TOF-PET scanner at UCL in Brussels. In order to derive accurate transmission values the data were corrected for randoms, scatter and decay.

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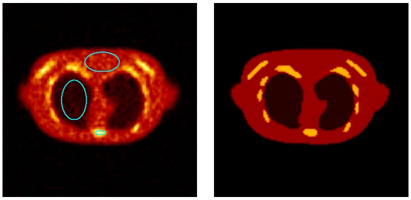
III. Results

Simulation results show that we were able to reconstruct the correct attenuation values for lung (0.00248 mm^{-1}), muscle (0.0097 mm^{-1}) and bone (0.0165 mm^{-1}).



(a)estimated attenuation (b)correct attenuation

Figure 1. Reconstructed attenuation map from simulation study.

The attenuation map of the uniform water phantom was reconstructed and a mean coefficient of 0.00957 mm^{-1} for water equal to the correct value was obtained

IV. Conclusions

TOF information can be used to separate the simultaneously acquired radiation of the annulus cylinder and the emission from the patient. By correcting for scatter, random coincidences and decay we are able to reconstruct quantitative attenuation maps which can be used to derive quantitative PET values.

References

[1] J. Nuyts, P. Dupont, S. Stroobants, R. Benninck, L. Mortelmans, and P. Suetens. Simultaneous maximum a posteriori reconstruction of attenuation and activity distributions from emission sinograms. *Medical Imaging, IEEE Transactions on*, 18(5):393–403, may 1999.